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ACCEPTABLE STANDARDS FOR NATURAL WATERS USED FOR BATHING

By Charles R. Cox, Assoc. M. ASCE

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PAPERS

ACCEPTABLE STANDARDS FOR NATURAL
WATERS USED FOR BATHING

BY CHARLES R. COX,¹ ASSOC. M. ASCE.

SYNOPSIS

Increasing interest in the public health aspects of bathing water quality has led to a study of standards suitable for the control of these waters. Quantitative bacteriological standards are difficult to apply without supplementary sanitary surveys and the exercise of seasoned administrative judgment.

Methods of evaluating pollution have not been developed sufficiently to permit assuming absolute standards. The connection between pollution of bathing waters and illness of people using these waters has not been thoroughly investigated.

Examples of codes based on quantitative standards are given as well as suggestions as to the proper application of these codes.

INTRODUCTION

Increasing interest in aquatic sports is leading to the construction of a large number of swimming pools and to the development of many natural bathing beaches. At the same time the currently active pollution abatement programs are focusing attention on the prevention of stream pollution in order to protect sources of water supply, shellfish growing areas, and natural bathing facilities as well as other natural water resources. These developments in turn have drawn attention to quality standards for natural waters. It is pertinent, therefore, to appraise the advantages and disadvantages of quantitative standards for bathing water quality to determine what, if any, quantitative guides or values may be developed.

ADOPTING STANDARDS

There is considerable confusion regarding quantitative standards, governmental requirements, codes, and objectives; and this confusion extends to the

NOTE.—Written comments are invited for publication; the last discussion should be submitted by December, 1951.

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appraisal of natural waters used for bathing. George C. Whipple² has presented a clear-cut distinction between governmental requirements and professional standards, procedures, or specifications. According to Mr. Whipple governmental requirements must represent the reasonable exercise of police power in a way that will be supported by court decisions as representing the necessary and legitimate use of such power to prevent injury. By contrast, professional standards, procedures, or specifications are established by agreement among professional groups or societies. If established by governmental agencies, these standards should represent guides to performance rather than rigid requirements established by law or by official codes. Therefore, professional standards or specifications may be higher or more rigid than governmental requirements inasmuch as their use is voluntary and may be modified or adapted to suit specific local needs.

This distinction made by Mr. Whipple may be illustrated by reference to standards for the quality of potable waters, because of their similarity to standards for bathing waters. The Drinking Water Standards of the United States Public Health Service (USPHS) apply specifically to potable waters used in interstate traffic, although these standards have been accepted as being applicable to public water supplies in general.³ The bacteriological aspects of standards are reasonably liberal and are subject to administrative flexibility, as contrasted to those parts of the standards applying to certain toxic substances held to affect the intrinsic quality of potable waters. The standards are applied through the administrative review of all factors surrounding a given water supply, including the reliability of operation and other intangible factors. By contrast, those operating water treatment plants have accepted the total absence of coliform organisms in all portions of the treated water examined as a professional guide or criterion to the quality of a plant effluent. Any surviving organisms are held to be specific indicators of ineffective treatment, even though their presence does not presuppose that the water is inherently unsafe for potable purposes. Therefore, in one instance the governmental requirements apply to the intangible "safety" of a potable water supply, whereas in the other instance rigid professional standards are used as a guide to measure treatment plant performance.

EVALUATION OF DATA

Bacteriological Data.—The characteristics and significance of bacteriological data available to those supervising bathing beaches should be considered as important aspects of any quantitative standards. Such data do not disclose the presence or absence of pathogenic organisms, and hence they are not a measure of any intrinsic health menace to those using the waters for bathing purposes. It is evident, therefore, that they furnish only an approximate quantitative measure of bacterial pollution of a miscellaneous nature, which must be appraised through the exercise of technical and administrative judgment. In fact, such bacteriological data do not distinguish between sewage

² "Governmental Requirements and Professional Standards," by George C. Whipple, *Journal, American Water Works Assn.*, Vol. 12, 1924, p. 61.

³ "Drinking Water Standards—1946," *Journal, American Water Works Assn.*, Vol. 38, 1946, p. 361.

pollution of public health significance and pollution by miscellaneous surface drainage from cultivated fields and other such sources.

These data are influenced also by the sampling error inherent in appraising any large volume of water by the examination of a very small portion represented by any one sample or even by a series of such samples. Furthermore, the samples represent conditions existing only at the time of collection, which may not apply specifically to conditions prevailing during other bathing periods. Although the results of the examination of a series of samples are statistically more significant than those for a single sample, some one single sample may be much more significant in indicating a serious degree of pollution that might prevail at some one time, and that might be of greater over-all public health significance than averages, medians, or some other statistical grouping of a series of results. Finally, fluctuations in the degree and extent of bacterial pollution are of basic significance, and yet it does not seem to be possible to establish any statistical limits for such fluctuations.

Bacteriologists have attempted to improve this situation by the development of appropriate identifying tests for the fecal group of coliform organisms which theoretically would be more specific for sewage pollution. They also have considered the use of a test for sewage streptococci which appear to survive in polluted waters for shorter periods than coliform organisms and therefore should disclose more recent sewage pollution. Without discussing the bacteriological aspects of this subject, it is sufficient to note that these investigations have not developed any tests for the degree of bacterial pollution of bathing waters more specific or of greater public health significance than the standard plate count and test for coliform organisms.

Accordingly, it may be concluded that bacterial standards for natural waters used for bathing cannot be placed on a precise quantitative basis and assumed to disclose the intrinsic quality of the water or to indicate certain public health safety for the bathers. Therefore, currently available bacteriological procedures should continue to serve as a general guide, the results forming part of the information pertaining to any given bathing beach, subject to coordinated administrative review.

Public Health Data.—There is a dearth of information concerning the public health significance of the bacterial pollution of bathing waters. Charles-Edward A. Winslow⁴ has reported on conditions prevailing at beaches in New Haven, Conn., as of 1926–27, and he has presented bacteriological data indicating the degree of pollution of these beaches which, according to epidemiological evidence, were held to be responsible for sixty-one cases of typhoid fever.

In general, the degree of pollution of the New Haven bathing waters at that time varied from low concentration of coliform organisms to 27,000 coliforms per 100 ml of water, with concentrations of 1,000 per 100 ml to about 6,000 per 100 ml predominating. These data definitely disclosed the need for sewage treatment to protect the beaches.

In spite of the lack of precise information, there is general agreement among sanitary engineers that natural bathing waters must be appraised as possible

⁴ "Bacterial Pollution of Bathing Beach Waters in New Haven Harbor," by C-E. A. Winslow and David Moxon, *American Journal of Hygiene*, Vol. 8, No. 3, p. 299.

vectors of water-borne intestinal diseases incidental to sewage pollution of such waters that may be swallowed by the bathers. Swimming pools, in contrast, may serve as possible vectors of infections of the skin and mucous membrane—that is, for the spread of infection from bather to bather.

The absence of subsequent epidemiological evidence—such as that gathered by Mr. Winslow relating the morbidity of bathers using specific beaches to the degree of bacterial pollution of the beach waters—has led to a tri-state survey of Lake Michigan waters by the USPHS and the Boards of Health of Wisconsin, Illinois, Indiana, and the city of Chicago, Ill. A preliminary report on sanitary surveys and examination of samples of water has been prepared by the USPHS,⁵ and an unpublished report of the epidemiological studies was presented at the 1949 conference of the American Public Health Association (APHA) by A. H. Stevenson and T. D. Woolsey. Unfortunately for the purposes of the tri-state study, the degree of bacterial pollution of the bathing beaches studied was quite moderate, and there appears to be no evidence of infections associated with the use of these beaches. Studies of beaches on the Ohio River testify that the degree of bacterial pollution is considerably greater.

Sanitary Survey.—It is evident from foregoing considerations that a given bathing beach must be appraised in the light of all available information, including any epidemiological evidence, analytical data, and more especially the result of properly organized sanitary surveys of the beach and surrounding waters. Such surveys should be designed to disclose the location, magnitude, and public health significance of sources of bacterial pollution and the relative influence of factors that govern the passage of such pollution toward a given bathing beach. Consideration should be given to the location of sewer outlets, the volume of tributary sewage, the dilution factors, the influence of tidal currents and meteorological conditions, the effects of rainfall and the resulting discharge of surface drainage into the bathing waters, and the effects of the bathers themselves on the degree of bacterial pollution.

Unless such thorough sanitary surveys are made, it will be impossible, for instance, for the administrator to distinguish between pollution by coliform organisms incidental to surface drainage from cultivated areas and more significant sewage pollution, or to distinguish between residual pollution from some distant sewer outlet and the same resulting degree of pollution by a smaller but near-by sewer outlet, which may be intrinsically more important.

Obviously, the sanitary survey must be made at the time the samples are collected so that the analytical data may be properly correlated with other observations. It should be emphasized again, however, that no statistical grouping of the results of the examination of a series of samples collected at various points and at different periods of time will permit the accurate correlation of the analytical data and specific observations made at some single point at a bathing beach. Conversely, the results of the examination of a single sample collected at a given point can have only limited significance applying to the time and place of sampling. It should be emphasized, therefore, that the analytical data must be considered as a part of the available informa-

⁵ "Tri-State Survey of Lake Michigan Waters," Preliminary Report, U.S. Public Health Service, Environmental Health Center, Washington, D.C., 1948.

tion disclosed by the sanitary survey, to be subject to administrative and technical scrutiny, and that these data have no intrinsic or precise significance. The exercise of administrative judgment, therefore, cannot be replaced by the mere checking of quantitative analytical data against rigid values used as specific governmental standards or code requirements.

In spite of this situation there have been repeated attempts to develop quantitative standards for the permissible degree of bacterial pollution of bathing waters. These efforts may have a sound basis when applied to artificial swimming pools where water treatment is practiced and where the permissible degree of remaining bacterial pollution is a measure of the effectiveness of the treatment process rather than a measure of safe or unsafe pool waters. In the past certain standards used for beaches, adopted from swimming pool practice, have been found so rigid as to be unworkable. Public health administrators, therefore, have been faced with the necessity of appraising bathing waters in the light of current practice, where large numbers of bathers are known to be utilizing beaches which are subject to appreciable bacterial pollution without any known effect on their health. It is not surprising, therefore, that the APHA Joint Committee on Bathing Places (hereinafter referred to as "the Committee") and the Conference of State Sanitary Engineers have concluded that it is not considered practicable or desirable to recommend any absolute standard of safety for the waters of outdoor bathing places on any of the technical or bacteriological bases reviewed in the 1948 report of the Committee. The Committee also concluded that the arbitrary wholesale condemnation of bathing beaches representing large capital investments is unwarranted without definite epidemiological evidence.

The pertinent question is whether, in the face of this situation, uniformity of practice can be encouraged by the development of guiding principles which are sufficiently flexible to permit the exercise of administrative judgment but, at the same time, are sufficiently definite to serve as useful guides.

In this connection attention is drawn to a resolution as to the significance of the coliform index as a measure of the pollution of bathing waters issued by the Great Lakes and Upper Mississippi River Boards of Public Health Engineers in 1937. The quantitative guide developed by the Michigan Stream Control Commission⁶ and tentatively adopted at that time by these two boards was based on the so-called Phelps Index or "Indicated Number"⁷ rather than the "most probable number." This index is based on the number of *B. Coli* present in a 100 cc sample.

It was resolved that in determinations of the actual extent and intensity of sewage pollution of the Great Lakes and tributary waters to be used in passing on the fitness of areas for recreational bathing purposes, the following interpretation of the significance of the *B. Coli* index should be tentatively adopted as a guide in connection with interstate problems:

⁶ "Coastline Pollution Surveys of Michigan, June, 1933," unpublished report of Michigan Stream Control Commission.

⁷ "Standard Methods for the Examination of Water and Sewage," American Public Health Association, New York, N.Y., 9th Ed., 1946, p. 205.

Index	Interpretation
10 to 100	Indicative of good water; normal for inland lakes and the Great Lakes; free of sewage pollution.
100 to 500	Normal for inland streams; free of detrimental sewage pollution; might be attributed to land wash.
1,000	Suspicious; generally indicates mild pollution in natural waters but dangerous in proximity to fresh sewage pollution.
10,000	Definite evidence of fresh sewage pollution; menace to health.
100,000	Heavy sewage pollution; definitely dangerous.

A review of available information on the subject of bacteriological guides discloses that sanitary codes applying to swimming pools and bathing beaches seldom contain any binding requirements as to the coliform density in bathing beach waters. There is a very definite trend, however, throughout the United States to adopt a median index of 2,400 coliform per 100 ml of water as an administrative guide. This policy has been followed in New York State where the Sanitary Code stipulates⁸ rather detailed requirements concerning the operation of artificial swimming pools, including the allowable degree of coliform density in chlorinated pool waters. The state code gives the local health officer and the State Commissioner of Health general administrative power to close a public bathing beach if, in their opinion, the use of the beach would menace the health of the bathers. No quantitative requirements are embodied in the code, however. In view of the fact that many very important bathing beaches in the metropolitan area of New York City come under the jurisdiction of a number of separate health departments, it has been found advisable to develop a joint policy as to the administrative classification of bathing beach waters in this area. This agreement has been subscribed to by all but one health department concerned. Briefly, this policy is predicated on the basic importance of the sanitary survey of each beach, supplemented by the interpretation of the analytical data in the light of such a survey. Beaches are classified in the joint policy agreement as "approved" (Class A) and "disapproved" (Class B), with distinctions as follows:

Class A. Approved beach waters are identified by:

- (a) Satisfactory epidemiological data pertaining to bathers utilizing the beach or adjacent beaches;
- (b) Satisfactory sanitary survey;
- (c) An average content of coliform organisms not in excess of 2,400 per 100 ml of water for any given series of ten or more samples from a beach.

Criteria (a) and (b) may sometimes justify the use of the lower average of 240 per 100 ml of water in criterion (c) for any given series of ten or more samples collected from a beach.

Class B. Disapproved beach waters are identified by:

- (a) Epidemiological evidence and experience which disclose the prevalence of infectious diseases incidental to the use of a bathing beach under consideration;

⁸ "Sanitary Code of New York State," New York State Dept. of Health, Albany, N.Y., Chapter VI, Regulation 12.

(b) A sanitary survey that discloses sewage material on a beach or in waters immediately adjacent to the beach;

(c) An average content of coliform organisms in excess of 2,400 per 100 ml of water for any given series of ten or more samples.

As in the case of Class A criteria (a) and (b) may sometimes justify the use of the average content of coliform organisms in excess of 240 per 100 ml of water for any given series of ten or more samples from a beach.

The joint policy agreement states that

"Conditions are expected to prevail which represent borderline cases between approved beach waters and disapproved beach waters. Administrative judgment must be exercised in appraising the uncertain factors and in assigning such borderline beaches to one of the two classes noted above. In any case, administrative judgment must be used in the periodic review of sanitary conditions prevailing at each bathing area and reclassification should be practiced when necessary, leading to the revocation of a permit for the operation of an unsafe bathing beach or to the issuance of public notice that certain beach waters are unsafe for bathing."

The New York State Water Pollution Control Board (hereinafter referred to as "the Board") has developed basic principles for the classification of natural waters including bathing beaches. Their problem was not to appraise an individual beach but rather to develop guiding principles for the required degree of treatment of sewage or industrial wastes to protect natural waters, including bathing waters. The effects of currents and meteorological factors cannot be anticipated in a precise manner. Therefore, the degree of sewage or waste treatment could not be selected so that they just met any given quantitative guide for the degree of pollution of the receiving water that may reach bathing beaches. The classification of natural waters by the Board, therefore, was predicated on comprehensive field studies of each stream or body of water.

SUMMARY

It is evident that knowledge and technical procedures have not been developed sufficiently to permit the development of precise quantitative values to measure the intrinsic quality of bathing waters, and, therefore, it is not possible to select a definite value that would distinguish between bathing beaches which are safe and those which are unsafe. Under these circumstances, precise bacteriological standards cannot be developed, and all available information must be considered in the light of properly organized and properly conducted sanitary surveys of each beach. These surveys would include the results of the bacteriological examination of samples of water. Under these circumstances general administrative guides may be fruitful in encouraging uniformity of practice as long as the guides are properly utilized without being considered as precise governmental requirements. It is hoped that the study of selected beaches on the Ohio River and of the morbidity among the bathers utilizing these beaches will furnish information needed for a more definite delineation of these problems, and also that more precise analytical methods may be developed to disclose the bacterial quality of bathing waters in a more definite manner than is now possible.

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